



# THE UNIVERSITY OF ARIZONA

TUCSON, ARIZONA 85721

LUNAR AND PLANETARY LABORATORY

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12 November 1965

Miss Winnie M. Morgan  
Technical Reports Officer  
Office of Grants and Research Contracts  
Office of Space Science and Applications  
National Aeronautics and Space Administration  
Washington, D. C. 20546

NASA-82

In re: Letter Progress Report  
61-inch NASA Telescope  
University of Arizona

Dear Miss Morgan:

Thank you for your letter of September 9 acknowledging my letter to Dr. Urner Liddel, with copy to yourself, as a "letter progress report" dated September 2, 1965. Please find enclosed herewith a further report covering the progress made during the last two months.

My letter of September 2 stated that several mechanical lesser items still required attention. The remaining work was carried out with all possible dispatch, with Mr. Sam Case, our design engineer, and his staff often working seven days a week and twelve or more hours a day to accelerate the program. The scientific staff was on hand for tests whenever needed. This program of intensive finishing up was essentially completed on October 7, 1965. With the assistance of staff members and our chief optician, we examined the image closely on that night and regarded it satisfactory. There were still a few residual mechanical troubles, one being with the clutches used in the right ascension and declination drives which appeared to be too weak and which prevented us from using preloads on the drives that were sufficiently powerful to minimize telescope shake in the presence of strong winds. These clutches were later replaced but did not prevent us from starting scientific observations on October 8.

Sixteen plates, 5 x 7 inches each, of the moon were obtained at the F/45 focus (scale 3 arc seconds per millimeter) on October 8 of which about half were already of "research quality," which means comparable to or better than the best plates of the moon obtained before of the areas and illuminations observed. On October 9, forty-one plates of the moon were obtained at the same focus of which nearly all were of research quality. No lunar observations were possible on October 10 but on October 11, twelve further plates were obtained, with the majority being of research quality. October 13 was an excellent night during which we obtained seventy plates of the moon, all of them of research quality and about half of superior quality with resolutions of about 0.2 arc seconds or better. A number of mediocre or poor nights followed during which no good lunar photography was possible. The program was resumed October 19.

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In addition to the lunar photography, many observations, visual, photography in black and white and in color, were made of the planets Saturn and Jupiter. Many of these results are of exquisite quality.

Dr. T. L. K. Smull, Grants Administrator of NASA, and Dr. William Brunk of the Office of Lunar and Planetary Sciences, visited the University on October 22 and participated in the dedication of the telescope. A copy of my comments made at the luncheon is herewith appended.

Since that time Dr. Low has made very important observations of the planets Saturn, Jupiter, Venus, and of several stars at 10 and 20 microns. The humidity of the atmosphere had dropped enough to open up the 20-micron window which is closed at nearly all U. S. observatories because of the much greater humidity. Results of singular importance have been obtained. One is that the planet Jupiter radiates more heat of internal origin than the amount absorbed from the sun and reradiated in the infrared. The ratio appears to be 2 or 2 1/2 to 1. A paper on this subject is in preparation, and Dr. Low is expected to be able to make an announcement within a week or so. He has also obtained drift curves at 20 microns of these planets across their disks both EW and NS, which give information on the vertical structure of these atmospheres. The belts of Jupiter stand out at 20  $\mu$  for their different temperatures, a most significant result for the interpretation of the condensation products and colors.

A second lunar program of two weeks was started about November 1 and is still running. About one hundred further lunar plates, many of excellent quality, were secured, as was very good additional planetary photography.

The scientific results to date have all been secured with the F/45 focus. The F/13.5 focus cage is ready for installation and tests which will be done at the completion of the present F/45 run.

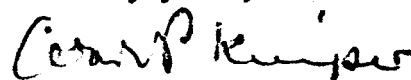
The blank for the UV optical cover plate, 45 inches in diameter, is scheduled to be ready for delivery in the latter part of December 1965, according to the most recent information received from the supplier.

A word should be added on the dome and building provided by the University of Arizona to house the 61-inch NASA telescope. I am completely satisfied with it, and the experience of the last month has shown that the thermal properties of the building are as favorable as anticipated. In particular, the fact that the dome has been painted with titanium dioxide white paint has had the desired effect of keeping the daytime temperature in the building low and making the dome cold at night which causes the air in contact with it to descend, leaving the air in the optical path in front of the telescope the undisturbed ambient atmosphere. My personal experience and that of our other observers has consistently been that "dome seeing" and "telescope seeing" are remarkably small and that the limit of resolution in the photographic image is almost entirely set by the atmospheric disturbances in the free atmosphere above the dome. I have personal experience with all the large telescopes in the U. S. except the Lick 120-inch and believe that it is fair to say that we have succeeded unexpectedly well in minimizing thermal effects within telescope and dome.

As was made clear in earlier correspondence, we have still to complete the third cell for the 61-inch telescope, housing the 45-inch plane-parallel optical plate when completed, hopefully sometime during the summer of 1966. (The production of the plane-parallel optical plate is a very difficult task but our optician should be able to do the work as well or better than anyone else.) Our previous request provided for a spectrograph attachment that has not yet been fully designed and will not be completed until sometime next year.

In conclusion, I am pleased to report that I am completely satisfied, as an astronomer, with the results achieved to date. The optics, good to  $1/40$ th of a wave, are better than those of any other large telescope. When the atmosphere is steady, images of the moon and of the planets are remarkably crisp and free from distortions. We have been able to observe the spots on the satellites of Jupiter in much greater detail than I have ever been able to observe them with the 82-inch telescope in Texas. We have an excellent instrument, but certain additions and improvements can and must still be made.

Sincerely yours,



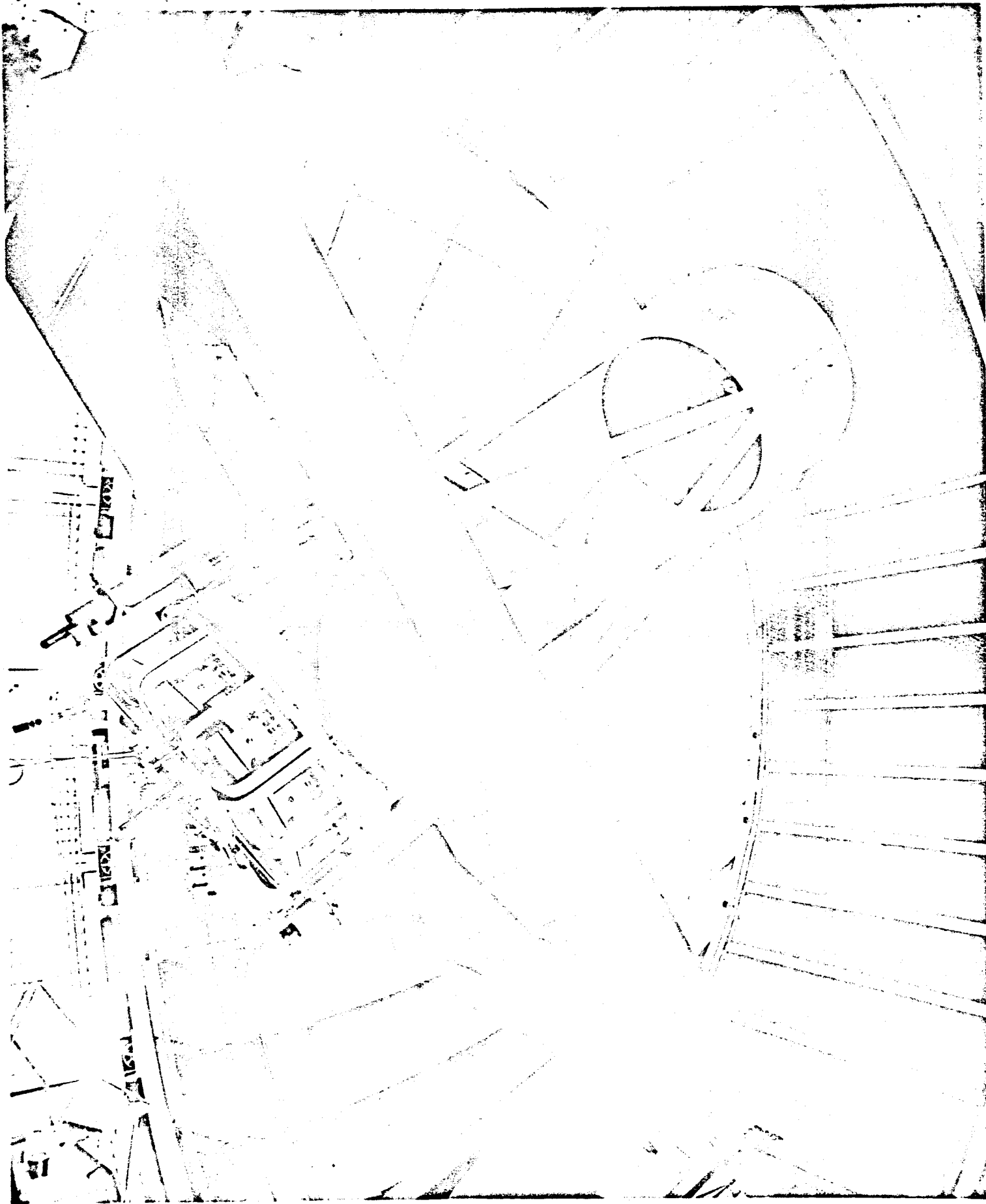
Gerard P. Kuiper  
Director

GPK:ie

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cc: Dr. Urner Liddel  
Dr. William Brunk

P.S. I am enclosing a print of a picture taken during night operations. We soon hope to have the time to take some daytime photographs which should be clearer.



22 Oct 1965

Dr. Small, Dr. Brunk, President Harvill,

Distinguished guests and friends:

As a spokesman for the scientists who will use the Space Sciences Building, I welcome the opportunity to make a few comments. The scientists at the University of Arizona interested in space-related investigations look upon the Space Sciences Building as a center for collaboration and for important new research.

The advances in the natural sciences, particularly planetary and lunar astronomy, geophysics in the broad sense, the investigation of the radiation belts surrounding the earth, and the plasma clouds blowing from the sun through the interplanetary space; all of these subjects have gained immeasurably from the large programs initiated by NASA. Also, the supporting technology is taking on completely new forms. The methods of investigation available to the scientist today are so much more powerful than those used only one or two decades ago, that we can speak truly of the birth of Space Science having occurred in the past decade.

University facilities have been able to keep up with much of this explosive development only through direct participation in the NASA programs. The Space Sciences Building on this Campus is dedicated to this proposition. Through it and with the facilities expected to be created in it, we hope to be able to make our contribution in the physical sciences during this remarkable period of history.

As you know, the facilities of this Building will be used by several departments:

- Aerospace and Mechanical Engr.
- Astronomy
- Chemical and Metallurgical Engr.
- Geology
- Lunar and Planetary Laboratory
- Meteorology
- Physics
- Psychology

It is not possible on this occasion to do justice to the careful plans laid by these departments for research in the Space Sciences Building during the coming several years. Let me list just a few.

The Lunar and Planetary Laboratory will be re-united in the Building, after its present operations are distributed over three buildings in Tucson, one on the Campus and two in the city. Its main programs will continue to be lunar and planetary photography; high-resolution spectroscopic investigations of planetary atmospheres both in the visual and in the infrared; infrared scans (heat maps) of the moon to longer and longer wave lengths, with apparatus for 20 microns being developed by Dr. Low for use during the coming winter; infrared detector development by Dr. Low, with advances of approximately 100 in sensitivity already being achieved between 1 and 2 microns; precision filter photometry in numerous wave length bands from the ultraviolet to the far infrared by Professor Harold Johnson; a massive program on the Orbiting Astronomical Observatory under the joint direction of Drs. Johnson and Gehrels; a high-altitude balloon program (Project Polariscope) directed by Dr. Gehrels; the development of an absorption tube with a very long path,

8 or 10 km, under the direction of Dr. Toby Owen, for simulated studies of planetary atmospheres; an extensive program of lunar cartography and an up-dating of lunar nomenclature, with close coordination with the International Astronomical Union which has entrusted our group with this program; close liaison with the Air Force lunar mapping program at Flagstaff, under NASA sponsorship; geological field studies related to the program of lunar exploration; and important editorial programs in the production of the two major handbooks in astronomy being produced during this decade, the 5-volume series "The Solar System," and the 9-volume series "Stars and Stellar Systems," under the overall editorship of Miss Barbara Middlehurst and myself.

Very significant programs are being carried out at the Institute of Atmospheric Physics. Dr. Herman will conduct laboratory studies of dust in the Mie region with an experimental program and supported by theoretical computations. His work has already been widely used at Kitt Peak, CalTech, and LPL. Dr. Staley has collaborated with Dr. Owen of LPL on the dynamics of the Jupiter atmosphere and other programs. The site of the Catalina Station is being used during the summer periods, when heavy rains occur, for a pulse Doppler investigation of rain drops from which the meteorologists are deriving important information on the dynamics of clouds. These results have a general bearing on the dynamics of planetary atmospheres and the formation of condensation products.

The participation of the Physics Department in the Space Sciences Building will include a Cryogenic program carried out jointly with Professor Frank Low. This is an essential component of infrared detector development which requires very low temperatures for optimum use. Also, included will be analysis of Dr. Bashkin's accelerator program (optical and ultraviolet

spectra obtained by bombardment of 2 meV ions).

The geological program will include lunar stratigraphic mapping, magnetic studies of meteorites and mapping of volcanic terrain. A very promising program in astronomy will consist of the development of a UVA spectrograph for Project Apollo and the development of further apparatus for its extensions.

I should like to endorse the comment made by President Harvill on the importance to the scientists at the University of the proximity of the Kitt Peak National Observatory. We have enjoyed the best relations with Director Mayall and the staff of the National Observatory, and have tremendously benefited from the use of their facilities on the mountain and from the assistance received through the staff. We are looking forward to a closer cooperation and integration of our efforts after our move to the Space Sciences Building, which will bring us adjacent to the Tucson offices of the National Observatory.

I should like to pay tribute also to the Architect of the Space Sciences Building, Mr. William Wilde, who is also the architect of our buildings at the Catalina Station. We appreciate the efforts he has made and continues to make to interpret our scientific and operational needs into inexpensive and functional buildings, which are pleasing in appearance and possess quality.

In conclusion, I should like to make a few remarks on the 61-inch telescope to be dedicated this afternoon at our Catalina Station. NASA



has funded a 60-inch telescope, but we managed to stretch it to 60.8 which we round off to 61. Mr. Robert Waland has produced optics of unsurpassed quality in a period of only about one year. The primary mirror is accurate to a fortieth of a wave. I want to express my appreciation and thanks also to Mr. Sam Case who was in charge of the design of the telescope and mounting, carried out with great skill and diplomacy our relations with Western Gear Company, and has worked so hard in the last three months during the period after the installation of the telescope to remove remaining weaknesses in concept or structure. We now have an excellent instrument, although it must be recognized that further refinements will undoubtedly be needed; and in any case, a third cage still needs to be constructed which will house a 45-inch plane-parallel optical plate of ultraviolet glass. This third cage will be used with the tube enclosed with insulating material in an effort to obtain the ultimate in resolution, of which the telescope should be capable, one-tenth arc seconds or about 600 feet on the moon. We have contended all along that this goal is achievable from an earth-based observatory, and I am very pleased to announce that already in the past two weeks of operation we have achieved a gain of resolution over the Photographic Lunar Atlas by a factor between 2 and 3. We have approached the ultimate limit of the instrument by a factor of 2 now, the photographic resolution achieved being 0.2 arc seconds. We are reasonably confident that with further effort we shall be able to reach the goal.

I want to express my thanks also to Mr. Nasmyth, Vice President of Western Gear Company, for the efforts his Company have made to produce a good mounting and a very excellent right ascension gear. It is fitting

that the first telescope built under Mr. Nasmyth's direction should be used for lunar studies, his great-great grandfather James Nasmyth, C. E., being the co-author, with James Carpenter, F.R.A.S., of the famous 19th century book, "The Moon," a copy of which I treasure on my shelves.

In conclusion, I would like to express my thanks to Mr. Clyde Doran, Regional Supervisor of the Coronado National Forest (Southern Arizona) and his staff for their interest in our Catalina Station. We are there the guests of the U. S. Forest Service and we appreciate their friendly understanding of our scientific needs.

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